National Renewable Energy Laboratory

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NREL

January 24, 1996

Chairman Yukio Naito
Hawaii Public Utilities Commission
465 South King Street
Honolulu, HI 96813

Dear Chairman Naito,

Enclosed is the final report on state-level renewable energy policy options that I have prepared for the Hawaii Public Utilities Commission pursuant to our arrangement with the U.S. Department of Energy. This final report incorporates comments and suggestions received from several of your staff.

Again, I appreciate and have enjoyed the opportunity to work with the Commission and to assist you in assembling this information. If I can be of any further assistance to the Commission in these matters, please do not hesitate to contact me.

Sincerely,

Blair G. Swezey
Principal Policy Advisor

cc: Joseph Galdo, DOE
Allan Hoffman, DOE
Val Jensen, DOE

Renewable Energy Policy Options for the State of Hawaii

A Report to the Hawaii Public Utilities Commission

Blair G. Swezey

January 1996

National Renewable Energy Laboratory
1617 Cole Boulevard
Golden, Colorado 80401-3393
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Preface

The National Renewable Energy Laboratory (NREL) is a national laboratory operated for the U.S. Department of Energy (DOE). NREL is a national resource committed to leadership, excellence, and innovation in renewable energy and related technologies.

This report is a result of a collaborative effort between DOE and the Hawaii Public Utilities Commission (PUC) to provide a systematic examination of state regulatory policies and procedures that facilitate the development and use of renewable resources. The information is being provided to assist the PUC in responding to a legislative request to conduct a study of strategies to facilitate the utilization of renewables in Hawaii.

One intended result of federal investments in renewable energy research and development (R&D) programs is the adoption and use of renewable energy technologies in the energy marketplace. Insights into the nature of energy markets can help to assure that the technologies being developed are compatible with these markets.

NREL's Analytic Studies Division (ASD) supports the long-range planning of the overall federal renewable energy R&D program, both at NREL and DOE, by conducting analyses on aspects of energy market competition that are relevant to the present and future deployment of renewable energy technologies. The ASD reports on these efforts to DOE and NREL managers, as well as external utility sector stakeholders, to enhance their awareness of competitive and institutional factors that may impact on the successful deployment of renewable energy technologies in the marketplace.

This work was sponsored by the Office of Utility Technologies in DOE's Office of Energy Efficiency and Renewable Energy.

About the Author

Blair G. Swezey is a principal policy advisor in NREL's ASD in Golden, Colorado. At NREL, Mr. Swezey evaluates the implications of current and prospective national, regional, and state policies for renewable energy deployment in the electric utility sector and is the program leader for NREL's Utility Analysis activities. Previously, he managed NREL's integrated resource planning activities. He has completed several studies on renewable energy economics and policies, and has prepared and presented testimony in several state utility regulatory proceedings. He is also editor of the *State Renewable Energy News*, a newsletter on state and utility renewable energy activities prepared for the Subcommittee on Renewable Energy of the National Association of Regulatory Utility Commissioners (NARUC).

Before joining NREL in 1987, Mr. Swezey spent more than eight years on the executive staff of the Electric Power Research Institute (EPRI) in Palo Alto, California.

Mr. Swezey holds a B.S. degree in Political Economy of Natural Resources from the University of California at Berkeley and completed graduate studies in Economics at San Jose State University.

NOTICE

Introduction

On April 15, 1994, the Senate Committee on Science, Technology and Economic Development of the Hawaii State Legislature passed a resolution requesting that the Public Utilities Commission (PUC) conduct a study on facilitating the use of renewable energy resources. Specifically, the legislature urged the PUC "to conduct a systematic examination of other states' policies and procedures which facilitate the development and use of renewable resources. The final report to the Legislature must contain a summary of the policies examined, identification of elements applicable to Hawaii, and recommendations for implementation of such elements."[1]

In response to the Senate Resolution, the PUC instituted a proceeding on renewable energy resources to "identify the policies, programs, procedures, and incentives necessary for the successful deployment of renewable technologies, such as wind power, biomass, solar, hydro and geothermal in Hawaii."[2]

The Senate Committee report accompanying the Resolution notes that "the State has the willingness and the resources to become energy self-sufficient through the use of renewable sources of energy" but that "Hawaii has not adopted regulatory policies to facilitate and encourage the development of these resources." This report examines the current status of renewable energy development in Hawaii and the United States, including the market and policy environment within which this development has taken place. However, it also recognizes that the electric utility industry is entering a period of fundamental change, toward greater competition, one in which the appropriateness of past policies that were promulgated in a regulated utility environment are being increasingly questioned. Prospective policies to encourage renewable energy development must be viewed within this context of changing market structure and opportunity.

Values Associated with Renewable Resources

Renewable energy represents a number of energy sources based on natural forces that are both replenishable on a cyclic basis and sustainable over the long term. These sources generally include the energy contained in the hydrologic cycle (hydropower), the heat of the earth (geothermal), wind and solar processes, and a number of energy sources based on plant or waste matter (wood and agricultural materials, municipal solid waste, and landfill methane).

The most important motivation for greater use of renewable energy sources in Hawaii lies in their economic and environmental benefits. Because renewable energy is derived primarily from natural and continuously replenishable sources, greater use of renewable energy sources contributes to a cleaner and more sustainable energy system. For example, greater reliance on

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[1]Senate Committee on Science, Technology and Economic Development, Seventeenth State Legislature, "Senate Resolution Requesting a Study on the Facilitation of Renewable Energy Resources Utilization," Standing Committee Report No. 3068, April 15, 1994.

[2]Hawaii Public Utilities Commission, Order, Instituting a Proceeding on Renewable Energy Resources, Including the Development and Use of Renewable Energy Resources in the State of Hawaii, Docket No. 94-0226, Order No. 13441, August 10, 1994.

wind energy, and other nonfuel-using renewables, avoids airborne emissions associated with fossil fuel combustion alternatives.

Development of the state's indigenous renewable energy sources can displace imported fuels, thereby reducing the outflow of the state income required to pay for these fuels. Renewables development can also provide localized benefits in terms of job creation.

Greater use of renewables has additional benefits. First, renewable resources are abundant in Hawaii and thus can help lessen the risk of fossil fuel supply disruptions and price fluctuations. Second, renewable energy sources are diverse. There are many different types of renewables that can be used, which reduces the risk of overreliance on any one energy source. Finally, some renewables-based technologies, such as wind and solar, can be deployed in modular fashion with short lead times, which decreases the risk in both the timing and the magnitude of generation investments.[3]

Renewable Energy Use and Policy in Hawaii

Because of its natural endowment, as well as its heavy dependence on imported oil, the State of Hawaii has longstanding policies of encouraging and promoting renewable energy development. As early as 1974, the State Legislature created a position of Energy Resources Coordinator (ERC) for the state, whose responsibility it is "to coordinate the efforts [and] . . . to formulate plans for the development and use of alternative energy sources. . . . so that there will be a maximum conservation and utilization of energy resources in the State." The state has also established more concrete energy policy goals of increased energy self sufficiency (in which the ratio of indigenous to imported energy is increased) and greater energy security, through increased diversity of Hawaii's energy sources, while at the same time recognizing the need for energy systems that are dependable, efficient, and economical.[4]

The State's Department of Business, Economic Development, and Tourism (DBEDT) leads efforts to reduce the high dependence on imported fossil fuels, with the DBEDT Director designated as the State ERC. Among the duties of the ERC is to formulate plans and objectives, and conduct programs for renewable energy development, and to recommend appropriate actions to the governor and the legislature. The ERC seeks to encourage renewable energy research and development, demonstration, and deployment and has done this through the establishment and promotion of a variety of renewables-oriented programs.[5]

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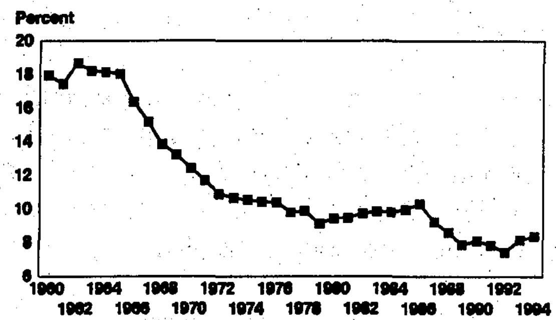
[3]The New England Electric System (NEES) has adopted an "option theory" approach to the incorporation of uncertainty in making long-term resource decisions. Shorter lead time investments offer the utility flexibility in being able to delay a resource decision and obtain better information on future market conditions. See the Company's *NEESPLAN 4: Creating Options for More Competitive and More Sustainable Electric Service*, November 1993.

[4]"Renewable Energy and State Policy," Presentation by Rick Egged, Interim Director and Energy Resources Coordinator, State of Hawaii Department of Business, Economic Development, and Tourism, to the Hawaii Public Utilities Commission Renewable Energy Workshop, January 26, 1995.

[5]Ibid. Also, see Department of Business, Economic Development and Tourism, *State Energy Resources Coordinator's Annual Report — 1994* for a description of DBEDT energy programs.

Despite the efforts of DBEDT and the ERC, historical data on renewable energy use in Hawaii indicate that the policy goal of increasing the share of renewable energy production and use is not being met. In fact, renewable energy use in Hawaii, as a percentage of total state energy use, has been on the decline (Figure 1). This trend obviously holds implications for whether the stated energy policy goal of increased use of indigenous renewable energy resources can be realized without further state action or encouragement.

Figure 1 - Renewables Percentage Contribution to Hawaii State Energy Mix



In Hawaii, transportation accounts for more than half (55%) of total primary energy use, while the electricity sector accounts for just less than 30% (Figure 2). Ideally, the development and utilization of renewable energy sources should be pursued in all energy-consuming sectors of the economy. However, the electricity sector, specifically, offers many different avenues for employing renewables today, while the near-term opportunities to tap renewables for transportation uses are more limited. Because of its flexibility as an energy form, electricity represents a very attractive carrier for conversion of renewable resources to useful energy. In fact, about 60% of all renewable energy use in the United States is in the form of electricity, compared to about 36% of all primary energy sources combined.

Currently, renewable energy resources account for 11% of Hawaii's electricity generating capacity (Figure 3). Excluding hydro, the renewables share is 10%, which is substantially greater than the comparable U.S. nonhydro renewables share of 2%. Nevertheless, the share of renewable electricity generation in Hawaii has been falling because of the downsizing of the Hawaiian sugar industry, which has resulted in the closing or fossil fuel conversion of several sugar mill generating facilities.

Figure 2 - Sector Mix of Energy Use in Hawaii (Excludes Most Renewables)

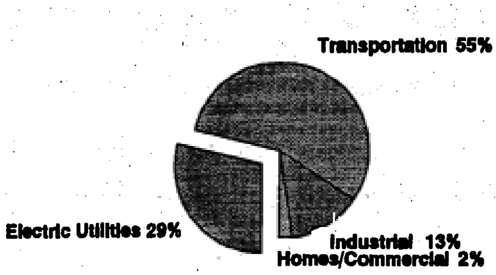
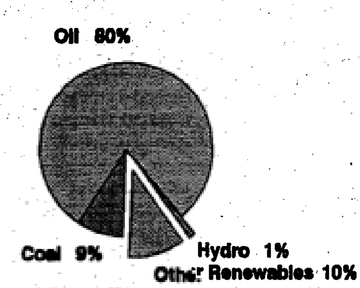


Figure 3 - Fuel Shares of Hawaii Electricity Generating Capacity - 1993



Renewable Energy Resources and Technologies

Different types of technologies are employed to convert renewable energy sources into useful energy forms. These energy forms include heat (thermal energy), liquid and gaseous fuels, and electricity. Renewable energy technologies (RETs) use various types of devices and equipment to collect and convert renewable energies. Because renewable energy sources tend to be more diffuse in nature than fossil fuels, a greater percentage of the cost of tapping these sources is incurred up front in the capital requirements for collection and conversion equipment. This is often referred to as the "front-loaded" cost of renewables development.

One important aspect of renewable electric systems is that they represent a spectrum of scale sizes from bulk power generation to smaller, distributed applications. For example, biomass power and geothermal generation systems are typically of the same size as small fossil power plants, i.e., 20 megawatts (MW) to 50 MW in size, while solar technologies, such as photovoltaics and solar water heating, can be sized to serve individual households.

Renewable energy sources also supply energy in different ways. Again, some renewable energy systems can mimic fossil generators in their degree of dispatchability (i.e., the ability to supply power on demand) while others, particularly those based on wind and solar energy, provide energy and power only when the resources are available. However, the existing utility system, as well as storage, can often be used to "firm up" the power from these intermittent renewable energy sources.

Much experience has been gained during the last 15 years with the commercial operation of renewable energy technologies; a total of more than 15,000 MW of nonhydro renewable energy capacity has been developed and successfully integrated into utility systems across the United States (Table 1). About 80% of this capacity has been developed by nonutility entities, primarily due to policies and incentives that have promoted nonutility development. As a result of this market stimulus, the costs of many renewables are now comparable to those of constructing new power plants using traditional utility fossil fuel energy sources. The results of several recent utility competitive bidding solicitations on the Mainland show that many different types of renewables projects have been offered in a price range of 4.5¢ per kilowatt-hour (kWh) to 6.0¢/kWh.[6] In June 1995, Northern States Power in Minnesota announced a winning levelized bid price of 3.0¢/kWh for development

Table 1 - U.S. Non-Hydro Renewable Electric Capacity and Generation - 1993

Energy Source	Capacity (MW)	Generation (Bil kWh)
Wood/Wood Waste	6,267	32.2
Agricultural Waste	648	3.3
Municipal Solid Waste	2,237	13.4
Landfill Gas	461	2.6
Utility Biomass	464	2.0
Wind	1,992	3.0
Solar	389	0.9
Geothermal	1,068	9.2
Utility Geothermal	1,739	7.6
Total Renewables	15,265	74.2

[6]These include bidding solicitations conducted by New England Power Company, Portland General Electric, and the three major California investor-owned utilities.

of a 100-MW wind project.[7] For comparison, weighted utility avoided energy cost rates (exclusive of capacity savings) across the Islands range from 3.2¢/kWh to 8.7¢/kWh.[8]

Hawaii is blessed with significant quantities of renewable energy resources of all types that can potentially be developed for commercial uses. DBEDT has documented this potential in many studies. For example, a DBEDT-sponsored report notes that "for most renewable energy technologies, a sufficient resource exists on each island to warrant consideration of an energy project." The report goes on to identify projects that "represent realistic opportunities for developing renewable energy in the State. . . (and that) would result in renewable energy making a significant contribution to Hawaii's energy mix."[9] Among the renewable resources examined were wind, solar, biomass, hydro, and wave and ocean thermal.

At the same time, the characteristics of the state's renewables resources and utility grids present special challenges for the integration of some renewable energy systems. The island utility systems are relatively small and are not interconnected. Also, the most attractive renewable resources for development may not be located in close proximity to the primary utility loads. These specific circumstances mean that large-scale renewable energy systems, typical of many bulk power applications on the Mainland, may not be as appropriate for the Islands.

The lack of grid interconnections means that Hawaii's utilities cannot take advantage of the operational diversity available to many contiguous utility systems on the Mainland, which allows these utilities to coordinate operations and achieve greater efficiencies in cost structure and in maintaining system reliability. Therefore, isolated utilities often plan for a greater level of system redundancy to achieve conventional levels of utility system reliability. On the other hand, the special nature of the Hawaii utility grids, where redundancy and high transmission and distribution costs result in comparatively high retail electricity rates, provides enhanced market opportunities for smaller scale, distributed renewable energy systems.

Finally, the availability of land for large renewable energy developments may be at a premium. Land is relatively expensive in Hawaii and may not be zoned for energy development. The time and cost of obtaining appropriate land use permits may be development impediments.[10]

The state of Hawaii already has important commercial experience with the development of its indigenous renewable energy supplies. DBEDT reports a total of 302 MW of installed generating

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[7]McGraw Hill, *Independent Power Markets Quarterly*, Third Quarter 1995, p. 60.

[8]*Stipulation to Resolve Proceeding*, Before the Public Utilities Commission of the State of Hawaii, Instituting a Proceeding to Investigate the Proxy Method and the Proxy Method Formula Used to Calculate Avoided Energy Costs and Schedule Q Rates of the Electric Utilities in the State of Hawaii, Docket No. 7310, March 4, 1994.

[9]R. Lynette & Associates, Inc., "Renewable Energy Resource Assessment Plan," Draft, August 27, 1993.

[10]R. Lynette & Associates, Inc., *Experiences with Commercial Wind Energy Development in Hawaii*, Electric Power Research Institute, EPRI TR-102169, April 1993.

capacity from renewable energy sources,[11] which provided 10.3% of Hawaii's electricity in 1993.[12] In addition, the solar energy industry estimates that the state's stock of solar water heating systems displaces an additional 60 MW, or about 2%, of generating capacity.[13] Below, the different types of renewable energy resources and technologies and the status of their development in Hawaii are briefly described.

Hydropower

Until the 1980s, very little renewable energy had been developed for power generation in the United States, except for hydropower. Hydropower represents a proven resource and technology that at one time supplied more than one-third of total U.S. power needs. However, with the growth of fossil fuel and nuclear generation, the hydropower share has declined to about 13% today. Also, the growth of hydropower has slowed as many of the largest and best sites have been developed. However, significant development potential remains for smaller development using "run-of-the-river" technology, which relies on natural water flow and avoids the need for large impoundment dams.

Several small hydroelectric generating plants operate on Hawaii, Kauai, and Maui, totaling 28.5 MW of capacity. The largest of these projects (12 MW) entered commercial operation in 1993 near Hilo on the island of Hawaii and provides about 6% of the island's total electricity needs. The power output is sold to HELCO. Hydropower has proven to be a stable, although relatively small, power source for Hawaii. Further development potential is limited by the lack of suitable river sites that remain to be exploited.[14]

Biomass

Use of biomass resources has been primarily associated with waste disposal, where the "fuel" is a by-product requiring disposal. This occurs in forest-related and agricultural operations, as well as in urban settings with municipal waste and landfill gas. Many businesses and municipalities have developed small generation systems that use these waste resources. Because these waste resources may become more scarce with greater use, industry researchers are investigating the farming of short-rotation woody crops as a way to significantly expand the future supply of biomass resources.

Biomass provides the largest fraction of the state's electricity contribution from renewable energy sources (Figure 4). The primary biomass energy source used on the Islands is bagasse waste from sugarcane production. The bagasse is fired in conventional steam boilers to cogenerate

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[11]"Status of Renewable Energy in Hawaii & the State's Promising Resources," Presentation by Maurice Kaya, Energy Program Administrator, State of Hawaii Department of Business, Economic Development, and Tourism, to the Hawaii Public Utilities Commission Renewable Energy Workshop for Docket 94-0226, January 26, 1995.

[12]DBEDT, *Annual Report — 1994*, *Supra* Note 5.

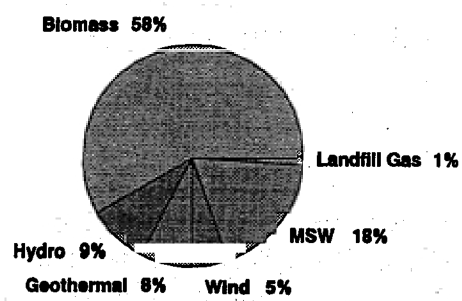
[13]Based on 60,000 solar water heaters installed, each displacing 1 kW of generation capacity.

[14]Rick Egged Presentation, *Supra* Note 4.

steam and electricity that is used directly in sugar mill operations; excess electricity generated is sold to the utilities.

The downsizing of the Hawaiian sugar industry means that less sugarcane is being grown and processed and, as a consequence, less bagasse is available as an energy feedstock. During 1994, two sugar mills ceased operations on the island of Hawaii, and a third closed on Oahu during 1995. As a result, less electricity will be generated using bagasse, and in fact, one facility has already been converted to operate on coal.

Figure 4 - Mix of Renewable Electric Capacity in Hawaii



Given the sugar industry downsizing and the potential for future declines in bagasse feedstocks, DBEDT has been investigating the potential to grow other crops as dedicated energy feedstocks. In addition, DBEDT has joined forces with the U.S. Department of Energy (DOE) to demonstrate the technical feasibility of producing a fuel gas from sugarcane bagasse. Biogasification, used in conjunction with a combined-cycle generating system, has the potential to double the efficiency of electricity production from bagasse.[15]

The contribution from municipal solid waste (MSW) combustion comes from a single plant on Oahu that began commercial operation in 1990. The project, serving the City and County of Honolulu, processes raw garbage to produce a "refuse-derived fuel." This fuel is then burned to generate as much as 60 MW of power, which is sold under contract to HECO. Outside of Honolulu, however, very little additional potential exists for MSW-based electricity generation. Finally, a small, 3-MW landfill gas project has been in operation since 1989 on Oahu. This technology may also be considered for other Honolulu landfills.[16]

Geothermal

Geothermal energy, thermal energy that exists beneath the Earth's surface, can be exploited for power generation or for direct thermal use. Conventionally accessed resources consist of either dry steam or hot water that is piped to the surface and run through power turbines, either directly or after the heat is transferred to a second working fluid.

Hawaii's existing generation contribution from geothermal energy consists of a 25-MW non-utility-owned project in the Puna District on the Big Island. The Puna project came on-line in 1993 following several years of government and utility-sponsored testing of the local geothermal resource. Although the operation of this project has been a technical success, the project has

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[15]DBEDT, *Annual Report — 1994*, *Supra* Note 5.

[16]Hawaiian Electric Company, *Electricity from Alternate Energy: A Progress Report from Hawaiian Electric Company*, March 1991.

encountered opposition from local residents on the basis of cultural and religious beliefs.

Current state policy supports the development of geothermal energy as a potential resource exclusively for the Island of Hawaii. Assessments indicate that the Puna geothermal resource is highly productive and capable of supporting the generation of additional power for the island.[17]

Wind

Wind turbines capture the wind's energy with rotating blades and convert this energy to electricity through a generator system. The turbines are mounted on towers to maximize the wind energy capture because the wind is generally faster and less turbulent farther from the ground. Although wind turbines can be operated in stand-alone systems, there are economic and operating advantages to siting wind turbines in large arrays or wind farms. Important progress has been made in the development of wind energy technology, with each successive generation of turbines realizing dramatic improvements in cost and performance.

Because of the strong and consistent trade winds, wind energy development has been pursued in Hawaii for almost twenty years, but with mixed success. During those years, HECO, either directly or through its HERS subsidiary, has been involved in several wind turbine demonstration projects. These turbines were generally first-of-a-kind technologies built by companies without a commercial track record in the wind industry. HERS also acquired a commercial wind farm that was developed between 1983 and 1985 using early generation, small-scale turbine technology. A study performed for the Electric Power Research Institute (EPRI) characterizes this early development as plagued by "poor turbine siting, overly optimistic energy projections, revenue shortfalls, and inappropriate station design," all factors that can be improved on.[18]

Today's wind industry has evolved through successive technology iterations such that mainland utility interest in wind generation has expanded enormously. Today, more than 15 utilities are actively pursuing or participating in wind energy development utilizing the latest technologies, which have availabilities of greater than 95% and much improved operational characteristics.[19]

Nevertheless, wind energy development offers an operational and integration challenge to Hawaii's utility systems. The wind plants already in place today on the Big Island can contribute from 9% to 23% of total demand, depending on the time of day. The HELCO system is characterized by long highly loaded and exposed transmission lines, lack of control over the operation of some large independent power generation, limited spinning and operating reserve capability, and no automatic generation control. However, another EPRI study found that even greater amounts of wind energy use could be accommodated by using advanced variable-speed

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[17]DBEDT, *Annual Report — 1994*, *Supra* Note 5.

[18]R. Lynette & Associates, *Supra* Note 10.

[19]S. Williams and B. Bateman, *Power Plays: Profiles of America's Independent Renewable Electricity Developers*, 1995 Edition, Investor Responsibility Research Center, Washington, D.C., June 1995.

wind turbine technology, which offers an improved electrical interface, and/or by making various operational improvements in the utility system.[20]

Wind energy systems are currently eligible for a 20% state income tax credit and a 1.5¢/kWh federal production tax credit. The continued availability of these credits is important to the economic viability of new wind energy development in the state.

Solar

Solar technologies for utility system application fall into several categories: direct thermal applications, thermal electric conversion, and direct electric conversion using photovoltaic (PV) devices.

<u>Direct Thermal Applications</u>

Solar thermal systems collect the thermal energy in solar radiation for direct use in low- to high-temperature thermal applications. Low-temperature applications include residential and commercial solar water and space heating; high-temperature applications include industrial process heat. The simplest (and most widespread) of the solar thermal technologies provides energy for domestic water heating. These systems typically circulate water through rooftop, flat-plate collectors and store the hot water in conventional household water tanks until needed. There are an estimated 1 million solar hot water systems in use nationwide, both in residential and commercial applications. Solar heating systems can also be used for commercial applications, as evidenced by a solar condominium project in Honolulu that provides for nearly 70% of the high-rise building's hot water needs.[21]

The Hawaii Solar Energy Association (HSEA) estimates that there are 60,000 solar water heating systems installed in the state, which provide 90% of the hot water requirements for an average of 3.9 people per system.[22] Hawaii offers an attractive venue for the use of solar water heating technology because of the state's abundant solar resource, a relatively constant year-round water heating load that leads to a high solar energy contribution, and the high percentage of electric water heating use that can be displaced.

There is a positive correlation between the level of state solar income tax credits and the level of solar water heating system installations in Hawaii. Tax credits help offset the impact of the front-loaded capital commitment of a solar system investment. Since the tax credit was raised to 35% in 1989, solar system installations have increased to more than 1000 annually from a level of about 400 systems under the former 15% tax credit. HSEA also estimates that 520 to

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[20]Electrotek Concepts, Inc., *Small System Performance Under High Wind Plant Penetration*, Electric Power Research Institute, EPRI TR-102784, August 1993.

[21]Solar Energy Industries Association, *Catalog of Successfully Operating Solar Process Heat Systems*, Washington, D.C.

[22]Data from the Hawaii Solar Energy Association.

640 jobs are associated with Hawaii's solar water heating industry.

HECO has proposed to offer customer incentives for solar water heating "retrofits" as a component of its Residential Efficient Water Heating (REWH) Program. The solar system incentive will be offered in conjunction with the state tax credit. HECO estimates that its program would result in the installation of more than 16,000 solar water heating systems over a 5-year period. However, HECO cautions that "if the state abandons the tax credit program, the (utility) may need to revise the program and reevaluate the cost-effectiveness of the affected measures."[23]

Solar Thermal Electric Conversion

Solar thermal electric systems use concentrating mirrors to produce higher temperatures that can be used with conventional power generation steam cycles. Three technologies have been pursued: the parabolic trough, the parabolic dish, and the central receiver, with these technologies being distinguished primarily by their different collection and conversion devices. Only the parabolic trough system has seen commercial application, with the other two technologies still undergoing research, development, and demonstration (RD&D).

To date, there has been little development activity with solar thermal electric technology in Hawaii, and none is currently being pursued or contemplated.

Photovoltaics

Photovoltaics represent possibly the most modular and flexible renewable energy technology. PV systems employ a solid-state device, or solar cell, to convert sunlight directly into electricity. PV systems operate unattended, with no fuel or cooling requirements, and no operating emissions or noise. However, because much of the current PV cell technology uses crystalline semiconductor materials (similar to integrated circuit chips), production costs have been high compared to those of conventional generation sources. Industry and researchers continue to search for and experiment with lower cost materials.

Even with higher costs, however, PV systems can offer unique advantages because they can be strategically located to maximize savings to the utility system. For example, several utilities have been investigating the distributed use of PV to relieve system stresses in heavily loaded distribution areas. Also, utilities are using PV to serve remote loads and displace costly dedicated distribution lines. Perhaps the ultimate distributed PV application is in rooftop systems, which locates generation with loads without environmental impacts such as fuel combustion emissions. Some utilities are currently investigating rooftop systems, and several states have adopted net energy metering policies that encourage homeowner investment in these systems.

[23]Hawaiian Electric Company, Inc., Application and Certificate of Service, Filing for Approval of a Residential Efficient Water Heating Program, Recovery of Program Costs and Lost Revenues, and Consideration for Shareholder Incentives, Before the Public Utilities Commission of the State of Hawaii, Docket No. 94-0206, July 20, 1994.

Hawaii has been active on several fronts in photovoltaics. MECO has been a participant in the federally-funded Photovoltaics for Utility-Scale Applications (PVUSA) program to demonstrate utility-scale PV applications and has installed, with DBEDT support, a 20-kilowatt (kW) unit on Maui. HECO is a member of the Utility PhotoVoltaics Group (UPVG) and is investigating the use of PV in remote applications.[24] DBEDT is also supporting PV development through its participation in the PV for Utilities (PV4U) program, which is a national collaborative to catalyze the efforts of key utility sector players to stimulate greater near-term use of PV in the utility market for both grid-connected and stand-alone systems.[25]

Ocean Thermal Energy Conversion

Ocean thermal energy conversion (OTEC) systems exploit the temperature differential between sun-warmed surface ocean waters and deep, colder waters. This differential, which can be as great as 36 to 38 degrees Fahrenheit, is employed in a vaporization cycle to drive a turbine generator. The requirement to maximize the thermal gradient limits the application of OTEC systems to more tropical environs. Research into OTEC development reached a peak in the late 1970s but has waned since.

The feasibility of the OTEC concept was first demonstrated in Hawaii in the late 1970s. An experimental open-cycle OTEC facility, with a 210-kW (gross) capacity, has been operational in Kona since December 1992 to examine the feasibility of larger commercial-scale applications of the technology.[26]

The Influence of Federal Energy Policies

Federal energy policy plays an important role in providing a framework for energy policy formation at the state level. Several federal actions during the last 20 years have provided an impetus for renewable energy development in the states. More recently, federal energy policies have focused on greater reliance on market forces to guide energy decisions.

The Public Utility Regulatory Policies Act

The Public Utility Regulatory Policies Act (PURPA) was passed by the U.S. Congress in 1978 as one of five laws to help reduce the nation's dependence on imported oil. PURPA expressly encouraged the use of renewable and waste energy resources in electricity production to conserve oil and natural gas. PURPA removed several market and institutional barriers to the development of these resources, which became known under the statute as "qualifying facilities" ("QFs"). First, electric utilities were required to interconnect with and provide nondiscriminatory backup power to QFs. Second, utilities were required to purchase power from these developers at the utility's "avoided cost," or the cost that the utility would have incurred by generating or otherwise

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[24] Rebuttal Testimony of Arthur Seki, Hawaiian Electric Company, Inc., in Docket No. 7259 (HELCO RT-4), 1994.

[25] DBEDT, *Annual Report — 1994, Supra* Note 5.

[26] Ibid.

supplying the power itself. And finally, PURPA exempted QFs from federal and state utility regulatory requirements. More than one-third of the capacity developed under PURPA has been renewables based, with the remainder coming from fossil-fuel-based cogenerators.

The implementation of PURPA brought about an important change in the electricity industry by opening the electricity generation market to a class of alternative, nonutility generators (NUGs). Before PURPA, NUGs had no market outlet for their generation, unless the local utility voluntarily accepted it. PURPA created a market focused on smaller, more efficient generation technologies (e.g., renewables and cogeneration-based plants), which had the effect of lowering the capital threshold for entering the power generation business. As the independent power industry has matured, NUGs now compete head-to-head with utilities in the development of larger, utility-scale plants.

The implementation of PURPA has not been without controversy. Utilities have long argued that PURPA required them to contract for power they did not need. More important has been disagreement over the determination of a utility's avoided cost. In PURPA, avoided cost was defined as "the incremental costs to an electric utility of electric energy or capacity or both which, but for the purchase from the qualifying utility or qualifying facilities, such utility would generate itself or purchase from another source." The regulations established by the Federal Energy Regulatory Commission (FERC) to implement PURPA did not specify a particular methodology for the determination of avoided cost, instead leaving it to the states to establish that the cost developed was "just and reasonable." In practice, there are a variety of alternative methods for determining avoided cost.[27] More recently, in states where competitive bidding or other competitive capacity procurement methods have been adopted, the administrative determination of avoided costs has become largely unnecessary. This is because the bidding process, by inviting participation from all prospective generators, reveals a market-based avoided cost.[28]

The efficacy of many avoided cost contracts signed in the early days of PURPA implementation are now being questioned by utilities. In some ways, PURPA has become a victim of its own success. Many of the early contracts contain high avoided cost payments that were based on projections of rising energy prices and high utility construction costs. With the competition wrought by PURPA having actually lowered the costs of new generation, as well as prices from existing generation, many of these contracts appear to be uncompetitive in today's electricity market.

Section 210(h) of PURPA allows utilities or QFs to petition FERC to review a state or utility's application of PURPA. Several utilities have contested the legality of state statutes or policies that require them to purchase power from QFs at rates above avoided cost. Connecticut Light and Power (CL&P) challenged a state law that required the utility to purchase power from

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[27]See S. Ferrey, *Law of Independent Power*, Volume 1, Chapter 7: Avoided Cost, Clark Boardman Callaghan, New York, NY, Release #6, September 1995.

[28]In reality, the bidding selection process is more complicated than this, because there are important nonprice factors that are also considered in project evaluation.

municipal waste generators at the municipal's retail rate. The FERC ruled that the state statute violated PURPA by mandating avoided costs that exceeded the utility's incremental cost of either generating the power itself or purchasing power on the market.[29]

Southern California Edison (SCE) and San Diego Gas and Electric (SDG&E) challenged the legality of a statewide bidding process in California that was restricted to qualifying facilities under PURPA. FERC ruled that the bidding process violated PURPA because a state must consider all potential supply sources in setting avoided cost.[30] However, FERC did not rule on whether the prices realized from the auction were actually above avoided cost.

FERC has been very careful to point out the narrow focus of these rulings; they relate only to the use of PURPA to promote particular energy sources. Indeed, in the SCE/SDG&E Order, FERC writes that "we acknowledge California's ability under its authorities over the electric utilities subject to its jurisdiction to favor particular generation technologies over others. We respect the fact that resource planning and resource decisions are the prerogative of state commissions. However, the State cannot pursue its policy choices in this regard under the guise of implementing the requirements of PURPA and our regulations."

And in his concurrence to the SCE/SDG&E Order, FERC Commissioner Massey noted that "our order in no way affects the authority of states to adopt and implement power supply policies outside of PURPA. Our order today construes only the requirements of PURPA, and does not (indeed, could not) purport to limit the authority of states beyond the context of PURPA. Our order says only that states cannot act under PURPA to require utilities to pay more than their avoided costs."

In its order on requests for reconsideration of its SCE/SDG&E decision,[31] FERC noted several ways in which states can act to encourage renewables development outside of PURPA. Although not intending to be definitive, FERC writes that

> as a general matter, states have broad powers under state law to direct the planning and resource decisions of utilities under their jurisdiction. States may, for example, order utilities to build renewable generators themselves, or deny certification of other types of facilities if state law permits. They also, assuming state law permits, may order utilities to purchase renewable generation.
>
> States also may seek to encourage renewable or other types of resources through their tax structure, or by giving direct subsidies. Use of the tax structure may allow states to affect the price of renewables or other alternatives. By imposing a tax on fossil generators or by giving a tax

[29] Federal Energy Regulatory Commission, *Order Granting Petition for Declaratory Order* (Connecticut Light and Power Company), Docket No. EL93-55-000, January 11, 1995.

[30] Federal Energy Regulatory Commission, *Order on Petitions for Enforcement Action Pursuant to Section 210(h) of PURPA* (Southern California Edison Company/San Diego Gas & Electric Company), Docket Nos. EL95-16-000 and EL95-19-000, February 22, 1995.

[31] Federal Energy Regulatory Commission, Order on Requests for Reconsideration (Southern California Edison Company/San Diego Gas & Electric Company), Docket Nos. EL95-16-001 and EL95-19-001, June 2, 1995.

incentive to alternative generation, states may allow the alternative generation to be more competitive in a cost comparison with fossil-fueled generation.

> A state may, through state action, influence what costs are incurred by the utility. Thus, accounting for environmental costs may be part of a state's approach to encouraging renewable generation. For example, a state may impose a tax or other charge on all generation produced by a particular fuel, and thus increase the costs which would be incurred by utilities in building and operating plants that use that fuel. Conversely, a state may also subsidize certain types of generation, for instance wind, or other renewables, through, e.g., tax credits.

The increased competition initiated with PURPA and the resulting market-induced lowering of generation costs brought into question the efficacy of the traditional monopoly organization of the electric utility industry. If greater competition in power supply led to lower generation costs, could further economies be gained by opening other segments of the power industry to competition?

The Energy Policy Act of 1992

For decades, electric utility companies have held exclusive territorial franchises to supply electricity. The granting of these franchises was premised on the fundamental belief that electricity generation and delivery is a natural monopoly, that is, there are a number of inherent characteristics of the electricity business that make it unamenable to competition. Some of the more traditional characteristics include the scale economies of operating a single transmission and distribution grid and the large capital requirements to gain entry into the business. Electricity is also considered to be a societal necessity and as such is "affected with the public interest." Regulation serves to protect consumers from exploitation by the exercise of the utility's monopoly power. In return for the granting of exclusive service franchises, utilities are assured recovery of prudently incurred costs and are allowed the opportunity to earn a "fair" rate of return on investment.[32]

Recent changes in the electricity market have brought into question the efficacy of this historical regulatory compact. The economies of scale inherent in the construction of electric generation plant were exhausted by the end of the 1960s.[33] The implementation of PURPA during the 1980s underscored this phenomenon by promoting the development of smaller scale, more efficient generators with lower costs than the large, capital intensive utility generators. As a result, significant regional electricity cost differentials have developed, exerting pressure on utilities to lower their rates.

The U.S. Congress further reinforced the trend toward greater competition in the electricity sector with the passage of The Energy Policy Act (EPAct) of 1992. Even with the greater number of power generators that had developed since PURPA, the lack of guaranteed market access

[32] J. Bonbright, A. Danielsen, D. Kamerschen, *Principles of Public Utility Rates*, Second Edition, Public Utilities Reports, Inc., Arlington, VA, 1988.

[33] R. Hirsh, *Technology and Transformation in the American Electric Utility Industry*, Cambridge University Press, New York, 1989.

remained a barrier to greater competition in wholesale generation markets.[34] With EPAct, Congress amended the Federal Power Act to allow any wholesale generator to petition the FERC for a transmission order, subject to certain conditions.

The FERC has established an aggressive timetable for meeting the EPAct requirements and addressing related issues. In a Notice of Proposed Rulemaking issued in March 1995, FERC proposes several rules to address transmission issues and guide the development of a more openly competitive utility industry. First, utility transmission grids will be opened, and utilities will be required to offer service to wholesale suppliers that is "comparable" to the level of service that it provides to itself and existing contractual partners. Second, utilities would be required to "functionally unbundle" their systems by separating the generation business from the transmission and distribution business. Finally, provisions would be made for existing utilities to recover their "stranded costs," or the costs previously incurred to service customers that may decide to contract for power with a new supplier.

Clearly, the implementation of EPAct will impose a new set of rules on the operation of the electric utility industry. It should result in a more dynamic market for electricity in which buyers and sellers alike will be free to negotiate their own power deals. At the same time, however, these developments bring into question the entire system of utility regulation that has been premised on the protection of the public interest in a monopoly-controlled market.

Tax and Financial Incentives

Since 1978, the U.S. Congress has employed a number of tax and financial incentives to help stimulate the commercialization of renewable energy technologies. Much of the renewables development through 1986 took advantage of these incentives to offset higher front-end costs and to compensate for the additional risk inherent in deploying new technologies in the commercial marketplace. Since 1986, federal financial incentives have been more sporadically available. With passage of the EPAct, Congress established (or continued) several incentives. It (1) permanently extended the 10% business investment tax credit for solar and geothermal projects, excluding public utility property, (2) created a production tax credit of 1.5¢/kWh for wind energy and "closed-loop" biomass systems, with public utility property eligible, and (3) authorized the creation of a 1.5¢/kWh production payment for solar, wind, biomass (excluding waste-to-energy), and geothermal (excluding dry steam) generation by publicly owned utilities and rural electric cooperatives.

State Policies in Support of Renewables Development

Against the backdrop of federal energy laws, incentives, and policies, the actions that states have taken in guiding electricity resource planning and procurement have been key to the success of renewables in the marketplace. In Hawaii, the influence of federal energy policies is apparent in the makeup of the state's energy program, which encompasses energy planning and policy, alternate energy development, and energy conservation. In addition, the PUC has established rules and other procedures relating to utility acquisition of renewable resources, which are

[34]Neither PURPA nor EPAct authorizes nonutility entities to make electricity sales directly to consumers.

modeled after the federal PURPA standards.

Many other states have recognized that the development of renewable energy resources offers benefits in terms of fuel diversity, environmental protection, and economic development, and that these factors should be considered in resource decisions in addition to comparative cost determinations. As a result, these states have adopted various policies to encourage renewable energy deployment. The different types of policies are described below.

Power Purchase Contracts

Much of the nonhydro renewables development of the 1980s occurred as a direct result of state policies to implement PURPA and provide power purchase contracts to nonutility project developers. Some states legislated their own versions of PURPA and actively promoted the development of the nonutility industry. States, including Hawaii, also adopted regulations that set forth procedures for the determination of avoided cost and for contracting with QF developers under PURPA. More than anything else, the ability of nonutility developers to secure long-term power purchase contracts from utilities, often in the form of standard offer contracts, has been the key factor in driving renewable energy development in these states.[35]

Net Energy Metering

Net energy metering (or billing) is a policy under which smaller electricity generators pay a single rate for the net difference between the amount of energy that they use from the utility and the amount that they supply to the grid. The small generator, who is also a utility customer, is reimbursed for the electricity supplied to the utility at the utility's (and customer's) retail rate instead of at the traditional avoided cost (or wholesale) rate. This policy is also known as reverse metering because the customer's electric meter (assuming a single meter) essentially runs in reverse when power is supplied to the utility.

Similar to investments in demand-side management (DSM), net energy metering provides an important incentive to small-scale renewable generators by allowing these generators to displace power normally provided by the utility company at the prevailing retail rate, rather than the traditional utility avoided cost rate, which tends to be much lower. Clearly, the higher the rate being avoided by the customer, the more attractive the renewable investment will be.

Electric utility companies argue that net energy metering results in lost revenues and a ratepayer subsidy because the utility must still maintain the facilities and infrastructure to service the small generator's load when its power demand exceeds it power output. Although this may be true, the utility will realize system benefits from the more distributed location of the small generator, particularly during peak periods. And in California, an analysis found that the metering, interconnection, and administrative cost savings from using a single meter under net energy metering, rather than the traditional dual metering approach, exceed the potential lost revenues

[35]J. Hamrin and N. Rader, *Investing in the Future: A Regulator's Guide to Renewable Energy*, National Association of Regulatory Utility Commissioners, Washington, D.C., February 1993.

to the utility.[36]

According to the American Wind Energy Association, net energy metering policies for small renewable generators have been implemented in 10 states.[37] In August 1995, California became the latest state to enact a net energy metering law. The California law applies specifically to solar electric generating facilities of 10 kW or less. In other states, various types of renewable facilities may qualify for net energy metering, up to 100 kW.

Financial Incentives

Financial incentives, such as tax credits, tax exemptions, and direct loans and grants, have been used by states to stimulate and encourage the development of renewables. For example, during the 1980s, California provided state income tax credits, as well as property tax exemptions, for solar energy development to match the credits offered by the federal government. More recent examples include Iowa, which offers various tax exemptions for landfill gas and wind energy systems; Minnesota, which provides loans and financial incentives to family farms and cooperatives for wind energy resource development; and Virginia, which offers an incentive grant for the development of PV manufacturing facilities within the state.

Very few states have adopted direct incentives to reward utilities for investment in or to purchase power from renewable-energy-based generation sources. Most recently, the Wisconsin Public Service Commission (PSC) established an incentive program "to reward utility use of renewable resources for generating electricity." An incentive of 0.75¢/kWh will be paid for qualifying wind and solar-based generation and an incentive of 0.25¢/kWh will be paid to all other qualifying renewables-based generation (biomass; co-fired, refuse-derived fuel; tire-derived fuel; and hydro). The incentive, which is collected through rates, is available for 20 years for both utility-owned and utility-purchased generation from new projects that are placed in operation or receive construction authority by the end of 1998.

Integrated Resource Planning

Integrated resource planning (IRP) developed as a more comprehensive process for comparing resource alternatives and addressing uncertainty in electricity planning. IRP addresses both the direct costs of power generation that have driven traditional resource decisions and indirect costs and benefits, such as relative environmental impacts. The existence of an IRP process provides a broader framework for the consideration of renewables in resource planning and procurement. Through 1994, 38 states had formal IRP-related processes in place, and 19 states (including 16 of the former) had adopted some type of IRP legislation.[38] Hawaii adopted an IRP "Framework" in May 1992.

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[36]California Solar Energy Industries Association, "SB 656 Net Metering Impacts on Pacific Gas & Electric Company," undated.

[37]*Wind Energy in the U.S.: A State-by-State Survey*, 1995.

[38]Edison Electric Institute, *Integrated Resource Planning in the States: 1994 Source Book*, Washington, D.C., 1994.

In Title I, Section 111 of the EPAct, the U.S. Congress formally endorses IRP as a mechanism that utilities should use for selecting future resources. IRP is defined as "a planning and selection process for new energy resources that evaluates the full range of alternatives, including new generating capacity, power purchases, energy conservation and efficiency, cogeneration and district heating and cooling applications, and *renewable energy resources*, in order to provide adequate and reliable service to its customers at the lowest system cost"[39] (emphasis added). "The process shall take into account necessary features for system operation, such as diversity, reliability, dispatchability, and other factors of risk. . . and shall treat demand and supply resources on a consistent and integrated basis." However, EPAct does not require states to formally adopt IRP.

Presumably, if an IRP process can adequately consider these and other important elements, it should properly capture the many positive attributes of renewables. However, state and utility IRPs differ markedly in their consideration of resource attributes. There are also differences in the degree to which the resulting plans are binding on a utility's resource acquisition process. Because IRP processes may not adequately consider the different resource attributes, some states have implemented additional policies to encourage greater attention to renewables.

Environmental Externalities

The valuation of energy market externalities, including environmental impacts, and the inclusion of such costs in resource acquisition decisions and electricity pricing can enhance the economic competitiveness of "cleaner" renewable energy projects when compared to those based on traditional fossil fuel resources. Mostly through the IRP process, states have begun to examine the externalities related to energy resource options and choices. By 1994, 29 states and the District of Columbia required electric utilities to consider externalities in their resource planning processes.[40] The Hawaii IRP Framework requires utilities to consider the environmental impacts of different resource options. Although HECO has established an advisory group on externalities, no significant results have yet emerged.

Of particular importance in externalities valuations is the treatment of carbon dioxide (CO_2) emissions. A comparison of state-adopted CO_2 emissions values shows that these values can differ quite markedly, from $1 to $23 per ton emitted.[41] As a result, CO_2 values can represent

[39]"The term 'system cost' means all direct and quantifiable net costs for an energy resource over its available life, including the cost of production, distribution, transportation, utilization, waste management, and environmental compliance."

[40]J. Fang and P. Galen, *Issues and Methods in Incorporating Environmental Externalities into the Integrated Resource Planning Process,* National Renewable Energy Laboratory, NREL/TP-461-6684, November 1994.

[41]B. Biewald and S. Bernow, "Climate Change and the U.S. Electric Sector," *Proceedings of the Fourth National Conference on Integrated Resource Planning*, National Association of Regulatory Utility Commissioners, 1992.

up to one-half of the externalities penalty ascribed to a new coal plant.[42] Because most renewables are emissions free, explicit accounting for CO_2 emissions could provide a substantial boost to renewables development.

However, to date, externalities rulemakings have not had much impact on renewable resource selection. In New York, for example, the consideration of environmental attributes in competitive solicitations for new capacity has had the general effect of favoring the selection of natural gas-based projects over coal-fired projects. Similar results have been experienced in Massachusetts.

Economic Development

Very few states have attempted to consider in-state economic development in resource planning decisions. Because the relative contribution of different types of projects to economic development is difficult to quantify, the criteria for consideration have been very general.

The Hawaii IRP Framework requires utilities to consider the impacts of different resource options on the state's economy. Also, DBEDT has developed a state energy system modeling capability and conducted comprehensive energy resource assessments that can be used to perform analyses of the economic impact of energy policy decisions. Initial assessments of alternate energy development scenarios indicate small but positive gains for the state in jobs and personal income.[43]

Studies have been performed in other states that attempt to measure the localized or state economic benefits of renewables development. A study conducted for Maine found that the encouragement of renewables-based cogeneration and small power facilities in the state has produced direct economic benefits of $120 million to $220 million, before consideration of environmental benefits.[44] And the Wisconsin Department of Administration calculated that more aggressive renewable energy development in the state could "generate about three times more jobs, earnings and output (sales) in Wisconsin than the same level of imported fossil fuel use and investment."[45]

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[42]Each $1 per ton value for carbon emissions roughly converts to a mill per kWh externalities penalty for a new coal plant. Thus, the higher value of $23 per ton translates into an externalities penalty of 2.3¢/kWh. For a comparison of total externalities values for coal and natural gas plants, see S. Wiel, "The New Environmental Accounting: A Status Report," *The Electricity Journal*, November 1991.

[43]State Department of Business, Economic Development, and Tourism, *Hawaii Energy Strategy Report*, October 1995.

[44]Economic Research Associates, et al., *Energy Choices Revisited: An Examination of the Costs and Benefits of Maine's Energy Policy*, Mainewatch Institute, February 1994.

[45]Wisconsin Department of Administration, Division of Energy and Intergovernmental Relations, Wisconsin Energy Bureau, *The Economic Impacts of Renewable Energy Use in Wisconsin*, April 1994.

Fuel Diversity

Generally, a broad mix of fuel and resource types provides diversity in utility power supply and reduces the risks associated with overreliance on any one particular fuel type. These risks may come in the form of fuel price escalation, fuel supply interruptions, or regulatory changes. Some states, including Hawaii, have attempted to explicitly account for the value of fuel diversity in resource planning considerations, however methodologies for accomplishing this are not well developed. For example, in New York, fuel diversity is considered important but it has been noted that "there are no standard criteria to determine when a system is sufficiently fuel diverse, nor is there a standard measure or definition of what fuel diversity means."[46] And the California PUC has also determined that protecting against "the financial risks of relying too much on a given fuel" is important but has yet to devise a diversity methodology.[47] Instead, the PUC established a renewables set-aside as an interim measure.

Set-Asides

Renewable energy set-asides offer an alternative means to assure some contribution from renewable energy sources. In such a program, a block of capacity is established for which only renewables are eligible to compete. This approach assures the recognition of renewables-specific resource and project attributes and also maintains the competitive benefits of traditional bidding schemes. A precedent for set-asides has been established by utilities that have held separate supply-side and demand-side auctions because of the difficulty of comparing these two types of resources in a competitive framework. Renewables-only solicitations also offer utilities unfamiliar with renewables a vehicle through which to evaluate renewable energy potentials and economics within its operating region.

Renewable energy set-aside programs have been established in California, Colorado, Iowa, and New York. In California, the renewables bidding solicitation under the state's set-aside was nullified by the 1995 FERC ruling.[48] Colorado and Iowa have established renewables set-asides

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[46]New York State Energy Office, Department of Public Service, Department of Environmental Conservation, *Draft New York State Energy Plan: 1991 Biennial Update,* Volume III, Issue Reports, Staff Report, Issue 6H: Fuel Diversity, July 1991.

[47]See California Public Utilities Commission, *Order Instituting Investigation on the Commission's own motion to implement the Biennial Resource Plan Update following the California Energy Commission's Seventh Electricity Report,* "Phase 1B Opinion: Changes to Final Standard Offer 4 for Use in Conjunction with the 1990 Electricity Report," Decision 91-06-022, June 5, 1991; and "Interim Opinion, Resource Plan Phase: Bidding for New Generation Resources," Decision 92-04-045, April 22, 1992.

[48]Despite the FERC ruling, the California PUC has expressed its expectation that the state's utilities adhere to the spirit of the renewables set-aside "to achieve the resource procurement statutory mandates, including mandates for diversity provided by renewable resources." California Public Utilities Commission, "Assigned Commissioners Ruling Regarding June 21, 1995 Public Discussion Endorsing Settlement," Dockets I.89-07-004 and I.90-09-050, July 5, 1995.

equivalent to 2% of new utility load growth and capacity, respectively.[49] And under a settlement agreement in New York, the state's utilities agreed to pursue development of between 303 MW and 387 MW of renewable energy-based projects, both utility and nonutility-owned. The settlement followed the establishment of a 300-MW renewable energy development goal in the 1992 state energy plan.[50]

Renewables-Specific Legislation

Finally, state policies and legislation that explicitly call for special consideration of renewables may provide a vehicle to accelerate renewables development. Many states with longstanding policies encouraging the development of renewables have achieved remarkable success in acquiring and integrating renewables into the state energy resource mix. California, for example, leads the nation in the amount of installed generating capacity from nonhydro renewables, having seven times more capacity than any other state.[51] Other states with established renewable energy policies, such as Maine and Vermont, have also realized significant renewables development.

Recent renewables policy statements and actions include:

<u>Colorado</u> — A 1994 state law "adds encouragement of renewable energy development to the factors to be considered by the (PUC) in setting and reviewing rates and policies of regulated utilities."

<u>Minnesota</u> — A 1993 state law establishes a state preference for renewable energy generation as a utility's first choice of power supply. The law states that "the commission shall not approve a new or refurbished nonrenewable energy facility in an integrated resource plan or a certificate of need. . . nor allow rate recovery (for such facility). . . unless the utility has demonstrated that a renewable energy facility is not in the public interest."

<u>Nebraska</u> — In 1995, the State Legislature passed a bill establishing renewables as preferred energy sources. The law states "that it is in the public interest to encourage energy efficiency and the use of indigenous energy sources" and allows utilities to give priority to energy efficiency and renewable resources in least-cost planning, to the extent practicable.

<u>New York</u> — The 1992 State Energy Plan recommended a market test/demonstration program

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[49]Elements of the Iowa set-aside have been challenged before FERC on avoided cost grounds. See Midwest Power Systems, Inc., Petition for Declaratory Order, In the Matter of the Sale of Electricity to Midwest Power Systems Inc. Pursuant to the State of Iowa Alternate Energy Producer Statute, May 31, 1995.

[50]New York Public Service Commission, *Case 92-E-0954: Proceeding on Motion of the Commission to Examine the Plans for Implementation of Renewable Resources as Part of Meeting Future Electricity Needs in New York State*, Settlement Agreement, October 12, 1993.

[51]N. Rader, *The Power of the States: A Fifty-State Survey of Renewable Energy*, Public Citizen, Washington, D.C., June 1990.

to procure 300 MW of a diverse range of renewable resources. As a result, the PSC initiated proceedings through which agreement was reached among all parties to acquire as much as 387 MW of new renewables.

Oregon — In 1994, the PUC established an overall policy goal that "utilities should conduct renewable resource assessment and confirmation activities in order to be prepared to evaluate and acquire cost-effective renewable resources to meet future (no later than the year 2000) resource needs." The PUC also adopted a staff recommendation that the commission "allow cost recovery of renewable resource costs which exceed the utility's avoided cost" when, for example, "the value of gaining experience with renewables or diversifying its resource mix justifies the additional cost." As a result, utilities in the state are actively exploring renewables development. One utility, Portland General Electric, has held a competitive solicitation for renewables projects through a green request for proposals or "green RFP."

Wisconsin — In 1994, the State Legislature established a goal "that, to the extent it is cost-effective and technically feasible, all new installed capacity for electric generation be based on renewable energy resources."

Renewable Energy Policy Options in a More Competitive Electricity Market

Past state policies to promote renewables have been crafted in a regulated electricity market regime. Where regulation continues to play a prominent role, these types of policies will still be important. However, as the electricity industry transitions to a more competition-oriented system, policy makers should look to develop policies that take greater advantage of market mechanisms. These policies should be directed toward both producers and customers alike. Some potential policies are discussed below.

Direct Access

One of the basic tenets of a competitive market is that there are many producers and consumers such that no one entity can control prices or access to the market. Producers must be able to reach consumers, and consumers must be able to access producers. However, in the traditional electric utility system, franchised utilities control access to the system at both the wholesale and the retail levels. Providing for direct access would empower renewables producers (or their intermediaries) to market green services directly to consumers and allow consumers to exercise a preference for green power by making purchases from renewables producers. This more competitive market construct would also help assure that the cost of green power is minimized. Primarily in an attempt to lower electricity costs, a number of municipalities on the Mainland are shopping for alternative power supplies in the wholesale market. However, some of these cities are also exploring power deliveries from renewable power suppliers as a component of their purchases.

Green Pricing

A large segment of the American public has consistently supported greater development of renewable energy sources, and utility surveys are also uncovering customer preferences for renewables.[52] As a result, a number of utilities are investigating the implementation of a "green pricing" service.

Green pricing offers an intermediate step to the direct access model by providing customers access to renewable energy through an optional green service or tariff to be offered by the utility. A price premium is charged to cover the incremental cost to the utility of acquiring renewable resources specifically for these customers.

The green pricing concept is generally considered to be most attractive for residential customers. However, utilities might also offer a green electricity product to its larger customers, such as municipalities or industrial and commercial customers, at a blended rate that would include a renewables component.[53]

Elements of the green pricing concept are based on the notion that new technologies are often purchased by "early adopters." Also, many consumers are willing to pay more for certain products which, all other things equal, are less detrimental to the environment. Proponents of green pricing argue that even if only a small percentage of customers was to "sign up" for the service, this could have an important "market pull" impact on the development of renewables. And many utilities favor the approach as a way of acquiring renewables for certain customers without impacting rates for its other, nonparticipating customers.

Critics of green pricing programs object to singling out a subset of utility ratepayers to fund a public good (i.e., the provision of a cleaner environment through the development of renewable energy sources) through voluntary contributions rather than public policy measures. Calculation of the price premium may be contentious because of disputes over avoided costs. Also, no alternative (competitive) green service may exist with which to benchmark the costs of the utility's program.

During 1995, at least three states formally approved the concept of utility green pricing programs: The Michigan PSC has approved a special green service for Detroit Edison customers for a planned 28.4 kW PV demonstration facility; the Nevada legislature has given the Nevada Power Company explicit statutory authority to provide a voluntary green service to its customers; and the New York PUC approved a proposal by Niagara Mohawk to develop a voluntary green pricing program, allowing customers to pay an extra $6.00 per month for electricity from renewables.

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[52]See, for example, B. Farhar, *Trends in Public Perceptions and Preferences on Energy and Environmental Policy*, National Renewable Energy Laboratory, NREL/TP-461-4857, February 1993, and D. Moskovitz, "'Green Pricing': Customer Choice Moves Beyond IRP," *The Electricity Journal*, October 1993.

[53]For example, Portland General Electric is packaging power from two planned wind projects for sale to wholesale customers. See *State Renewable Energy News*, Fall 1995, available from the National Renewable Energy Laboratory.

Risk Allocation

In a regulated utility system, utility shareholders and ratepayers share in the risks of most utility investments because utility investments are incurred for the purposes of providing necessary services to consumers and the public at large. As long as these costs are prudently incurred, utilities can expect full cost recovery as well as a reasonable return on the investment.

Controversy may develop when actual costs exceed planned costs. Examples may include cost overruns on a new power plant or the costs of retroactively imposed environmental compliance measures. In Hawaii, the heavy reliance on oil-fired generation makes the electricity system particularly vulnerable to shifts in the price of oil, the impacts of which are generally collected through a fuel cost adjustment clause (FAC).

Because of the assurance of cost recovery, the existence of an FAC provides little incentive for a utility to avoid the risks associated with reliance on any particular fuel. In Hawaii, this works against renewables, because although renewables may provide some value in diversifying the fuel mix, these values are not recognized in the marketplace.

A competitive market can introduce a more proper allocation of the risks of fuel and technology choices. All other things equal, a supplier would bear the economic and financial risks of a sudden increase in the cost of fuels or of retroactive environmental compliance measures, just like a renewable energy developer selling to a utility bears the risk of resource quality or equipment performance. Utilities in several states already operate today without FACs.[54]

HECO argues that elimination of the fuel adjustment clause would simply raise rates to customers because the utility would bear the full cost implications of these risks. The company argues that "it makes sense for the customer to bear the risk of fuel price variability rather than to pay a higher price for electricity in order to eliminate the risk."[55] But this is the crux of the matter, that internalization of these risks necessarily increases the price of electricity from more risky sources. In a competitive market, customers would have the choice of paying a higher fixed rate for renewables as a source of insurance from these risks, just as homebuyers can choose a fixed rate mortgage as insurance against interest rate fluctuations.

Targeted Financial Incentives and Disincentives

State governments can exercise significant influence over energy markets through tax and other fiscal policies, such as tax levys and exemptions, tax credits, depreciation schedules, loan guarantees, and other financial devices. The use of these devices can help mitigate the higher

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[54]States that currently have no automatic fuel clause for major electric utilities include Arizona, Kansas, Missouri, Montana, Oregon, Texas, Vermont, and Wisconsin. See R. Morgan, "Time to Face FACs: How Fuel Clauses Undermine Energy Efficiency," *The Electricity Journal*, October 1993.

[55]HECO, "Barriers and Strategies," Working Draft 5/30/95, prepared as input to the Hawaii renewable energy docket working group.

front-end investment requirements for renewables. Important examples in Hawaii are the state income tax credits for solar and wind energy systems.

In addition, state utility regulators authorize the rate of return for jurisdictional utilities. Thus, PUCs can reward utilities by increasing the rate of return or penalize them by decreasing the rate of return. This device could be used as an incentive for utilities to make prudent investments in renewables. Looking forward to a more competitive electricity market structure, some regulators are investigating the use of performance-based ratemaking (PBR) for utilities.[56] Under a PBR-type mechanism, renewables deployment progress could be one utility performance factor by which earnings would be determined.

System Benefits Charges

Many states are considering establishing a "universal wires charge" that would collect a standard fee from all electricity customers to fund programs that may no longer be feasible for the utility to provide in a more competitive electricity market. The institution of a wires charge arises most often in discussions of a utility's "stranded costs" for which a "competition transition fee" would be collected from ratepayers to recover uneconomic costs that might result from exposing the utility company to greater competition.[57] In a restructured utility system, it is generally anticipated that the charges would be collected at the distribution level.

The wires charge concept is also relevant as a "system benefits charge" for the provision of public programs, such as energy conservation, renewables and low-income assistance, that have previously been supported in utility rates. In Arizona, a customer surcharge has been adopted to fund a utility's Energy Efficiency and Solar Energy Fund. In addition to recovery of demand-side management expenses, the surcharge covers all capitalized and expensed program costs associated with the development and implementation of renewable energy projects.[58]

Green RFPs

Green RFPs refer to competitive bidding solicitations for new generation resources that are limited to renewable resources. Rather than negotiate separately with any one developer, an open and competitive solicitation encourages developers to offer their lowest cost resources in competition with each other. A cap can also be placed on the price that the utility is willing to pay for these resources. Green RFPs conducted by mainland utilities indicate that a number of different renewable energy resource options are available that can provide clean and cost competitive power for ratepayers over the long term.

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[56]L. Hill, *A Primer on Incentive Regulation for Electric Utilities*, Oak Ridge National Laboratory, ORNL/CON-422, October 1995.

[57]These stranded costs relate to those utilities with high embedded costs, some portion of which may not be recoverable from customers in a more competitive market in which electricity prices may fall.

[58]Arizona Corporation Commission, Decision No. 58644, In the Matter of the Commission's Examination of the Rates and Charges of Arizona Public Service Company, Docket No. U-1345-94-120, June 1, 1994.

Portfolio Standard

A renewables portfolio standard would impose a minimum renewable energy requirement for the state's electricity mix. Every entity participating as an electricity supplier would be required to provide and maintain a certain percentage of its supply from renewable energy sources. However, the renewables obligation would be tradeable so that all electricity suppliers need not become renewables providers. For example, electricity suppliers could contract with dedicated renewables developers to meet their renewables obligation. Such a trading scheme would enhance the value of renewable energy resources in the state and at the same time use market forces to minimize the costs of developing and maintaining the portfolio. The trading element of the portfolio standard is patterned after the sulfur dioxide (SO_2) trading program contained in the Clean Air Act Amendments of 1990. The establishment of a renewables portfolio standard has been proposed as an element of the California PUC's recent electric industry restructuring decision.[59] A renewables portfolio standard could also be employed more broadly to include all sources of energy used in the state, including transportation.

Summary and Recommendations

The State of Hawaii has an abundance of indigenous renewable energy resources, the development of which can lessen the risks and financial burdens associated with the importation of fossil fuels. Renewable energy development can also provide the state with greater diversity and environmental sustainability of its electricity supply. Renewable energy technologies have developed to the point that they are either today already cost competitive on a life-cycle basis in many applications or are approaching cost parity with traditional electricity sources.

Important progress has been made in the development of renewable energy resources in Hawaii. However, despite these advances, the share of renewable energy use has been declining because of the sugar industry downturn. Greater use of renewable energy in Hawaii's electricity sector is currently impeded by the following:

- Renewable energy systems tend to be capital intensive and thus require a greater initial outlay of capital investment.

- Many of the values that renewables possess, such as environmental benefits and the economic and security benefits of displacing imported fuels, are not directly captured in electricity market decisions.

- Electric utilities are today the sole providers of electricity on the Islands. If the utilities do not actively pursue or participate in the development or acquisition of renewables, the development of these resources is significantly impeded. Furthermore, the state's consumers, who may prefer greater development of renewable resources, can only exercise this preference through the services that the utility provides, short of making their own system investments.

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[59]California Public Utilities Commission, Order Instituting Rulemaking on the Commission's Proposed Policies Governing Restructuring California's Electric Services Industry and Reforming Regulation, Decision 95-12-063 (December 20, 1995) as modified by D.96-01-009 (January 10, 1996).

Several strategies could be pursued to promote greater renewables development. These strategies, which are not mutually exclusive, fall into two general categories: (1) providing greater incentives for utilities and other power supply entities to develop or pursue renewables (or disincentives for not doing so), and (2) providing alternative avenues for electricity consumers to access renewables if utility service offerings are not responsive to their preferences or to the achievement of state policy goals. Associated policy actions might include:

<u>A Tangible State Renewables Goal</u> — First and foremost, the state needs to make a clear pronouncement that renewable energy development remains an important objective of state energy policy. The state might consider the establishment of a concrete goal for renewable energy development and the development of policies to support the realization of this goal.

<u>Renewables Preference</u> — The state could also establish an official preference (similar to that adopted in Minnesota) that all new generating capacity should use renewable energy resources unless it can be demonstrated, on a case-by-case basis, that this would not be in the public interest. Any such analysis should include explicit consideration of fuel supply and price risks, as well as environmental and economic development impacts.

<u>Targeted Financial Incentives</u> — The state might provide incentives to help move Hawaii's energy industries toward greater renewables development. The state currently offers income tax credits for the installation of solar and wind systems to help defray the higher front-end costs of these systems, and these credits should be maintained. Incentives could also be provided to utilities as a reward for prudent renewables programs or and investments. These incentives could be funded either out of general revenues or by a "systems benefit charge" for renewables development that all electricity customers would be required to pay; the systems benefit charge could be used to establish a "State Renewables Development Fund."

<u>Portfolio Standard</u> — The establishment of a portfolio standard would promote development of the most cost-effective renewables by creating a market specifically for renewable energy development and allowing utilities and other electricity suppliers to trade renewable energy allowances. The portfolio standard could also be extended to other energy-consuming sectors.

One of the more important obstacles to greater renewables development in the electricity sector is that market power is concentrated in the hands of the state's electric utility companies. Although there is ample historical and economic rationale for today's regulated monopoly utility system, this market concentration serves to impede alternative types of investments, such as renewables, unless the utilities are willing participants. Outside of making changes to the utility incentive structure, the response to which cannot be known in advance, several types of reforms could be initiated that focus on promoting greater competition through providing for greater customer access to renewables.

<u>Green Power Marketing</u> — At the very least, the state's utilities should develop a "green power" product that would allow the utilities' customers to voluntarily exercise a preference for electricity from renewable energy sources. However, assurances should be provided that the renewable energy service to be offered is a competitive product, perhaps by holding a "green RFP" for the new projects to be developed or allowing third party entities to develop and offer

similar products and services.

Direct Customer Access — Alternatively, third party entities might be allowed to provide renewable energy service options directly to a utility's wholesale and retail customers. The terms of this access must be fair so as not to discriminate against or unduly impact the cost of the renewables-based power.

Net Energy Metering — Because of the large spread between utility wholesale electricity prices and retail rates in Hawaii, there is a considerable potential for small-scale, distributed renewable electric systems, such as photovoltaics, to make market inroads on the customer side of the meter. A net energy metering policy, which would allow customers to offset their high retail rates and which many other states have already implemented, should be considered.

Recommendations for Particular Renewable Energy Resources

Biomass — Bagasse has provided the bulk of the state's contribution from biomass resources. However, with the sugar industry on the decline, alternative biomass resources and conversion technologies must continue to be explored and pursued, including the exploitation of the state's waste resources.

In addition, the short availability of the federal production tax incentive for generation facilities using "closed-loop" biomass resources provides a near-term incentive to accelerate the investigation of these resources.

Geothermal — Geothermal resource development has just recently started contributing to the state's electricity mix. The state should seek avenues for expanding the use of the geothermal resource where appropriate. A 5-MW expansion of the existing Puna project is currently being negotiated.

Wind — Hawaii has attractive wind resources, but past commercial development experience has been disappointing. The state should explore mechanisms for encouraging the deployment of improved wind turbine technology. Similar to "closed-loop" biomass, the short availability of the federal production tax incentive for new wind energy generation provides a near-term incentive to move ahead with actual projects.

Solar — The enhancement of the state income tax credit has revived the solar water heating industry in Hawaii. In addition, HECO has proposed a customer-oriented solar water heating program that, in conjunction with the tax credits, will help ensure that this momentum is sustained. These types of programs should be continued and encouraged.

Perhaps the most promising long term application for solar electricity in Hawaii is the use of photovoltaics. Although PV-based electricity continues to be more expensive than bulk power generation, the economics become more favorable the farther into the distribution system PV systems are considered. Given the relatively high retail rates in Hawaii, the potential for customer-oriented PV systems deserves near-term attention. The state should explore options for encouraging these applications.

Ocean Thermal Energy Conversion — OTEC systems offer a longer term potential for clean electricity from an indigenous, renewable energy resource. Efforts should continue in the research and development of this technology.